

The Age of Oil

- Beginning of the End?

by

Colin Campbell and **Jerry Gilbert**
ASPO IRELAND BARRELMORE LTD

www.peakoil.ie

Do we really appreciate our oil?

- Prices (per pint)
 - Gasoline: \$0.30
 - Milk: \$1.00
 - Bottled Water: \$1.50
 - Orange Juice: \$0.50
 - Cappuccino: \$15.00
- Daily Consumption (per person)
 - Food 2,300 k cal
 - Oil-based energy >100,000 k cal



Why do we need to know what's left?

Oil and gas now dominate our lives:

40% of traded energy is oil

>90% transport fuel is oil

Trade depends on transport

Fuels much electricity generation

Critical for agriculture

Fuels the tractor, transports the produce

Basis for synthetic nutrients, pesticides

Why is it so important ?

Oil and gas dominate our lives.

- 40% of traded energy comes from oil.
- More than 90% of transport fuel comes from oil.

Trade depends on transport.

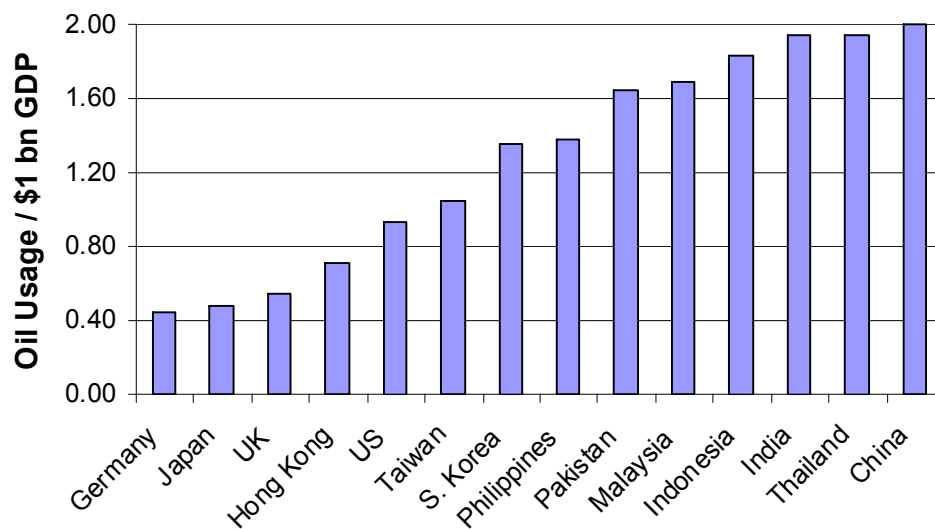
Much electricity is generated from oil and gas.

Oil and Gas are critical for agriculture : people need to eat

Oil fuels the tractor and brings the produce to the cities.

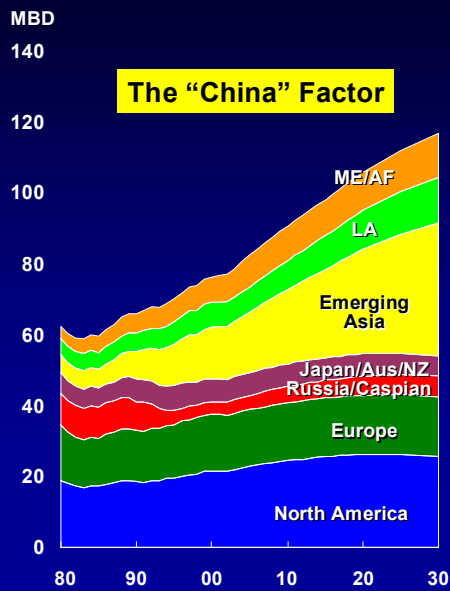
Gas gives synthetic nutrients on which new crops depend.

Oil Usage Intensity - 2004

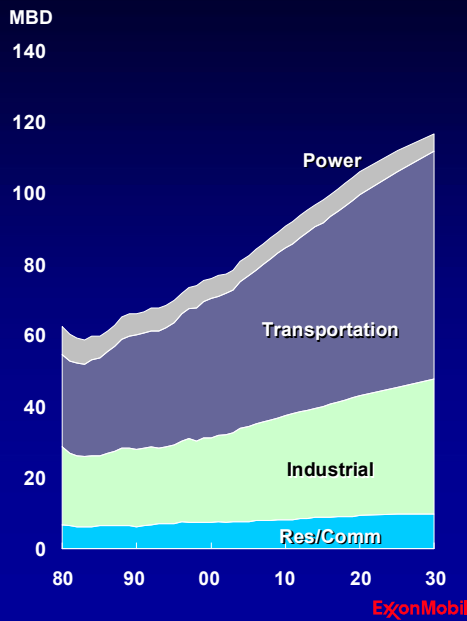


World Oil Demand

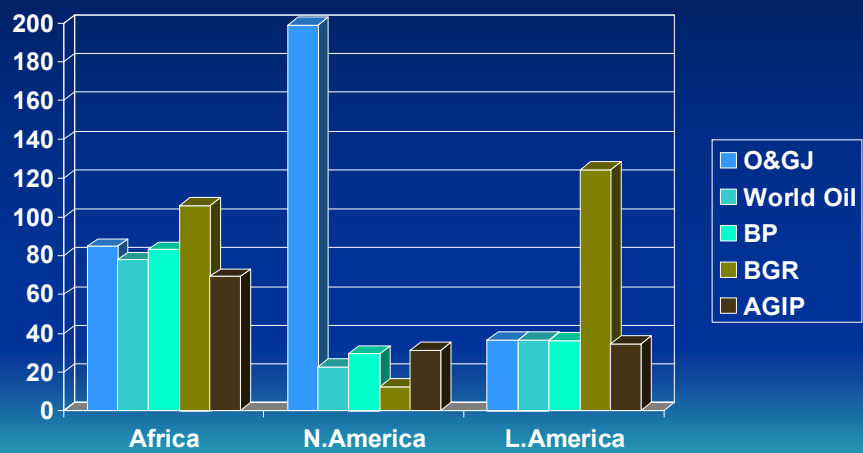
By Region



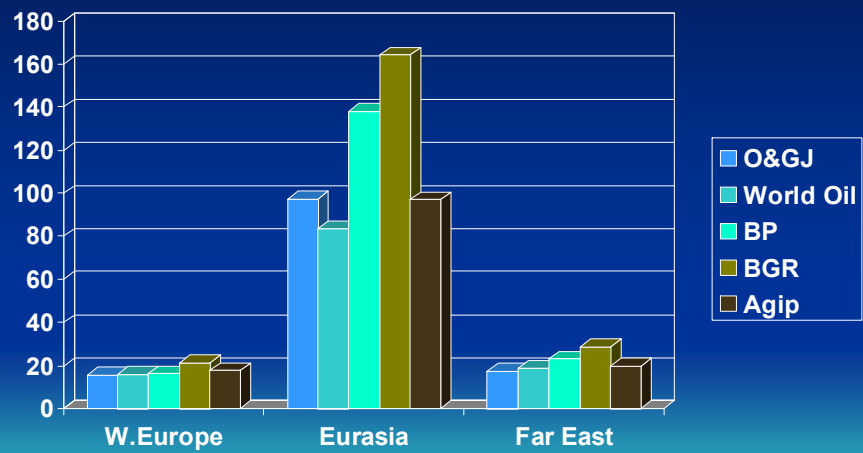
By Sector



Conflicting Reserve Data - 1



Conflicting Reserve Data - 2



Why is there so much uncertainty?

- ***Most of world's remaining oil is in the Middle East, under Government control***
 - Strong reserves vital to their economies, secrecy a strength in rate negotiations

Oil companies regard reserves data as commercially secret

- Won't give us information which might lead to a move away from hydrocarbon dependency or give a competitor an advantage

Archaic Reporting Standards

- US SEC refuses to accept current technology

Outline

1. Geological Reality

“You have to find it first”

2. Discovery and Production start and end

Growth is followed by decline

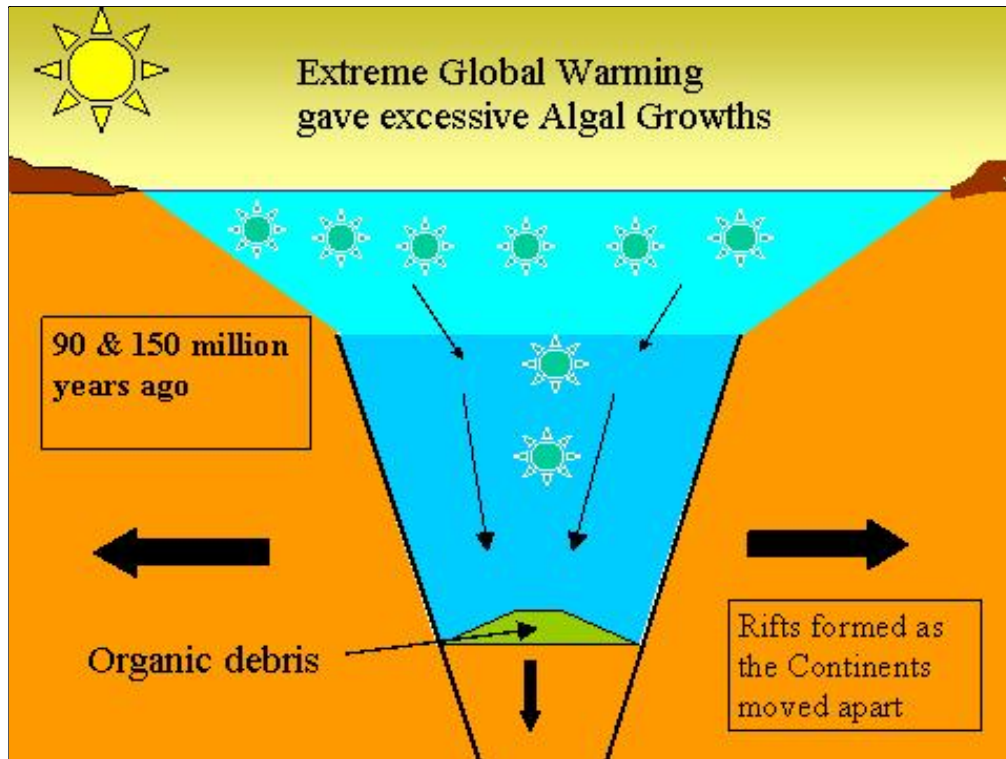
3. Dangerous Confusion

4. Consequences and - perhaps - solutions

I will start by emphasising what I call Geological Reality.

- You have to find oil before you can produce it. Finding oil depends on geology: so an understanding of petroleum geology is the bedrock for forecasting future production.
- Oil and Gas were formed in the geological past. It follows that both discovery and production in any area, and eventually the world as a whole, must start and end, passing a peak in between, when about half the total has been consumed.
- It seems so obvious and yet it runs counter to our mindset. We are not used to limits. We don't go around thinking our death beds, yet we know we are aging.
- I will try to explain the confusion.
- I will then move on to consider the consequences and possible reactions.

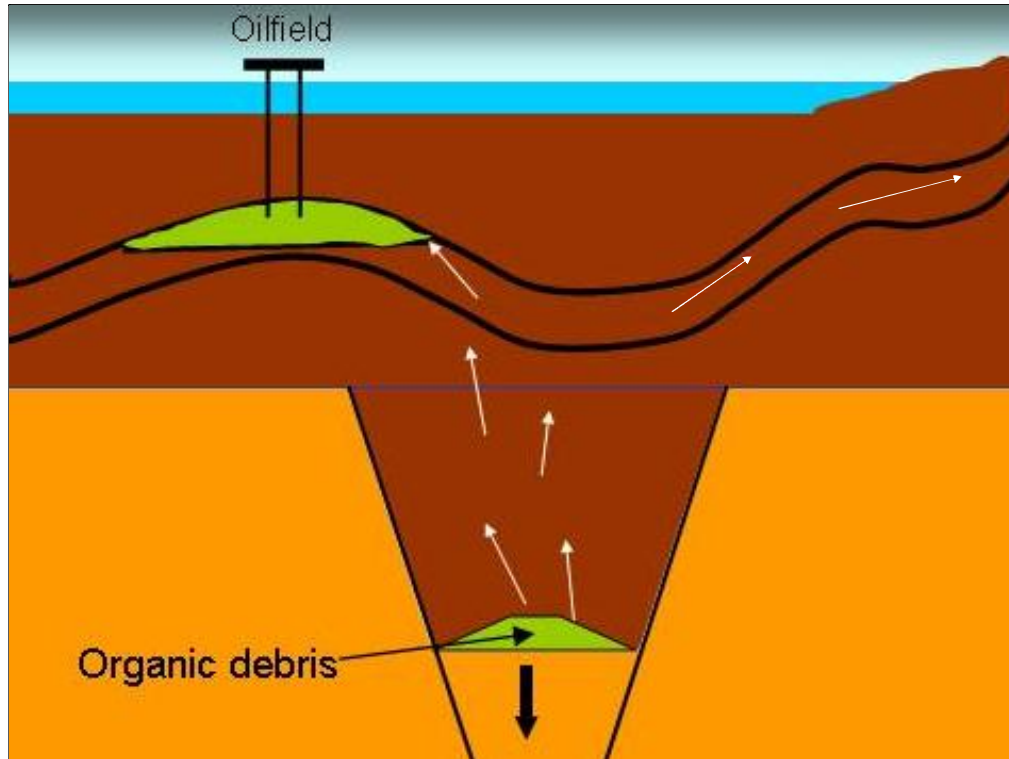
In looking at the political and economic reactions, I freely admit to moving into territory on which I can claim no professional qualifications.



What were those black, stinking shales we found in the mountains of Colombia? They were of mid-Cretaceous age, in what we now know to be one of two prime epochs of generation.

- They were caused by extreme global warming, 90 and 150 million years ago.

Algae proliferated in the warm sunlit waters, and the organic debris fell into stagnant rifts, which were formed as continents moved apart. It formed the raw material for oil.



Later, the rifts were filled by sands and clays washed in by rivers from the erosion of the borderlands

- When buried to about 2000m, the organic debris was heated enough for chemical reactions to convert it to oil.

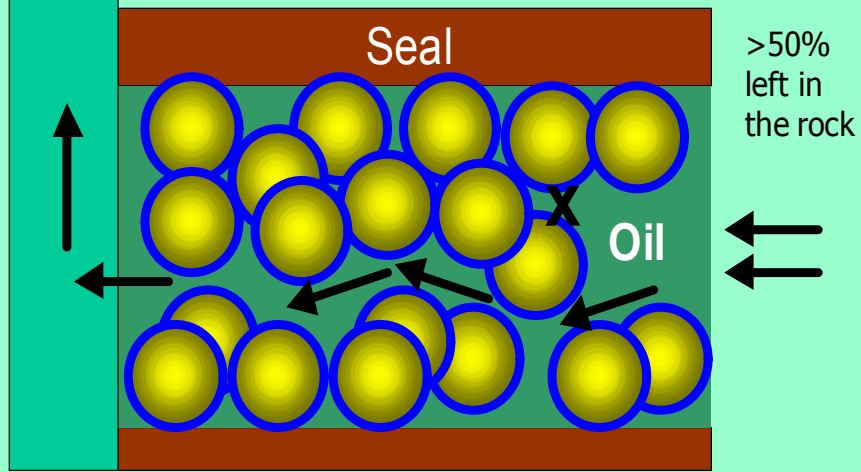
- The rifts themselves were later buried by younger sediments, which were in turn folded and fault by earth movements as mountains rose.

The oil, once formed, began to move upwards.

Much was lost but some found its way into geological traps, floating on the water the normally fills the pore space between the grains of rock.

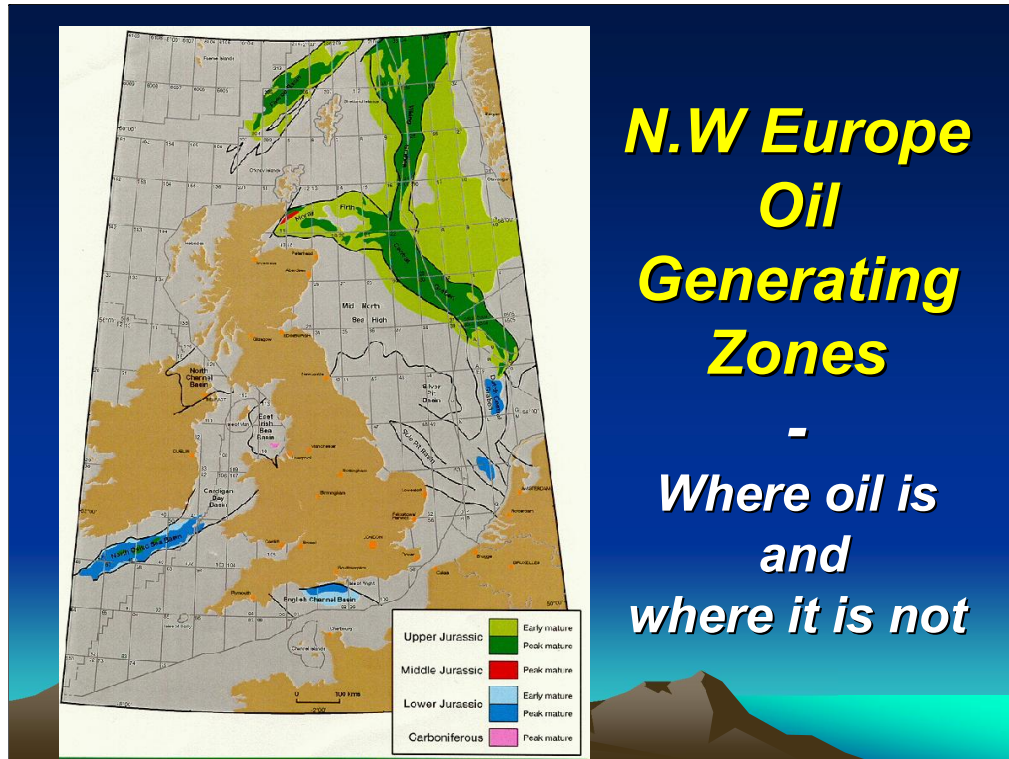
Well

What a Reservoir looks like



Oil fills the pore-space between the grains of sand, which are coated in a film of water. The oil has to flow through these constrictions.

9



This is where oil was formed in North-West Europe.

The green area is a prolific belt of oil generation lying in a Jurassic rift, which formed as the Atlantic began to open 150 million years ago: the older of the two prime generation epochs.

- It is largest new province found since the Second World War, holding about 60 billion barrels, enough to supply the world for less than three years.

The world has been studied enough to find all the major productive areas. They are not difficult to identify once the key information has been gathered from a few initial boreholes.

- But some possibilities remain for smaller new areas with leaner sources, such as depicted in blue and red.

Mining coal or minerals is largely a matter of concentration. Lower concentrations become viable if prices rise or costs fall.

- But oil is different. It has a certain polarity : it is either there in profitable abundance, or it is not there at all. That reflects the rare occurrence of prolific source-rocks in Nature.

A Fixed Quantity

Oil was formed in the geological past

- We can't "grow" more

Are we Running Out? –

- We started running out with the first barrel!
- ...but the last barrel is far in the future

The important fact is –

Production decline begins when half reserves are gone

To say it again:

Oil was formed in the geological past : we cannot grow more.

People ask: "Are we running out of oil"?

The simple answer is : *Yes, we started doing that when we produced the first barrel*

But finally running out is not the issue. That won't happen for a very long time, if ever.

•Much more important is the pattern of depletion.

Production starts to decline when about half has been consumed. Decline is primarily driven by the immutable physics of the reservoir, although political and economic factors may intrude.

This is the issue that should concern us. It is a very serious one.

Depletion is Easy to Understand

As every beer drinker knows:

- the glass starts full, and ends empty*
- the quicker you drink it, the sooner it's gone*

The same principle applies to oil and gas

How has this reality been concealed ?

It is so obvious

*– yet to many it is a **devastating realisation***

Depletion is easy to grasp as every beer-drinker knows.

- The glass starts full and ends empty.
- The quicker you drink it, the sooner it is gone.
- The bar shuts at closing time.

The same principle applies to oil and gas.

We may ask how this self-evident reality has been concealed and confused.

Although self-evident, it is a devastating realisation with huge implications for the modern world.

We may lack the mental courage to accept it, but Nature does not lie.

Bad Information

Issue would be self-evident with valid data

Public data are grossly unreliable.

Governments have been seriously misled.

Official institutions under political pressure.

Influence of outdated economic theories

'Supply must meet Demand in an Open Market '

'Substitutes naturally arrive as needed'

***Skills of a detective needed, but true position
can be determined.***

The issue of depletion would be self-evident if valid information were available to the public.

Governments have been misled partly by the malign influence of outdated economics.

- They proclaim that supply must always meet demand in an open market and
- that substitutes naturally arrive as needed.

Official institutions, such as the International Energy Agency, are under political pressure to obscure and confuse, providing governments with a curtain behind which to hide.

The skills of a detective are needed to smoke out the true position, but it can be done.

Why is there confusion?

Oil companies reported Reserves to meet strict Stock Exchange rules

- Designed to prevent fraudulent exaggeration
- Smiled on conservative reporting

Discoveries under-reported, revised upwards later

- Comforting but misleading image of steady growth
- No conspiracy - just simple commercial prudence

OPEC over-reported

If it is that important, why were n't we told ?

Engineers are perfectly capable of making good estimates of the size of an oilfield early in its life.

But oil companies reported *Commercial Reserves* under strict Stock Exchange rules, having their origins in the special environment of the United States.

- They were designed to prevent fraudulent exaggeration but smiled on conservative reporting as laudable prudence.

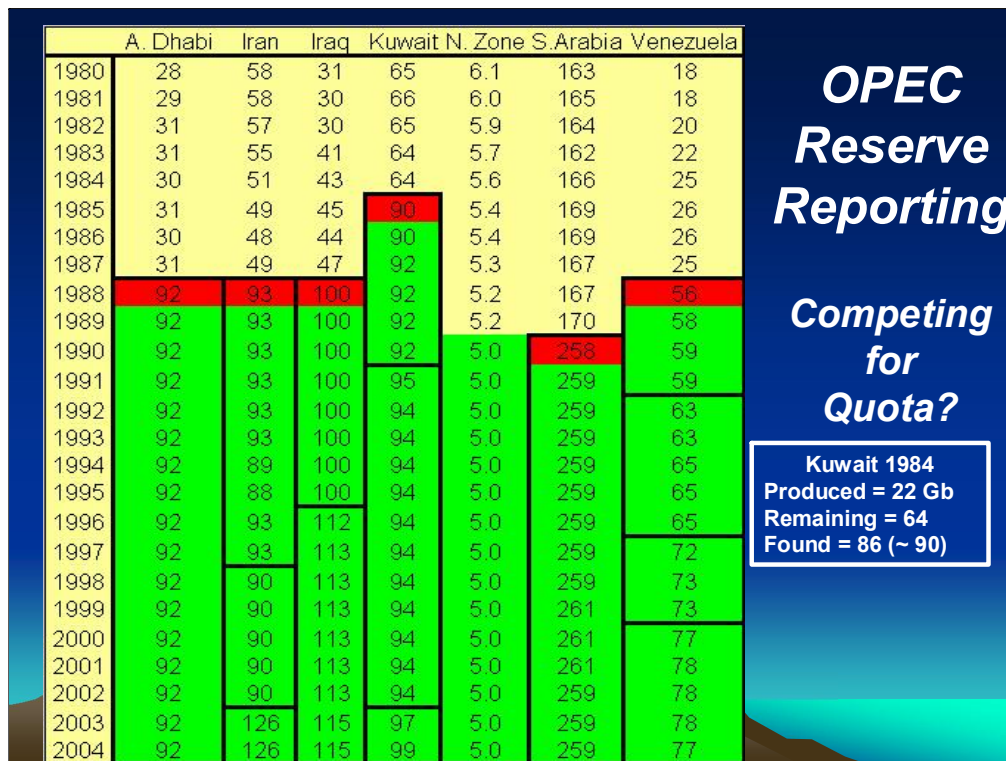
In short, the major companies reported the minimum they *needed* to report to provide a satisfactory financial return.

The low reported reserves were therefore subject to upward revision over time which presented a comforting but very misleading image.

It was not conspiracy or trickery, just pragmatic management under the rules.

OPEC for its part exaggerated, as its members competed with each other for quota based on reported reserves.

In short, public numbers are very unreliable.



Let us look at how OPEC reported.

In 1980, Kuwait reported reserves of 65 Gb (billion barrels), which has fallen to 64 Gb by 1984. 22 Gb had been produced by then, meaning that a total of 86 Gb discovered.

In the following year, it increased its report to an implausible 90 Gb : in other words, it reported about what it had found, not what remained. It did so because OPEC quota was based on reserves, and prices were low.

At first, the other countries did not know how to react. But when in 1987 Kuwait increased again to 92 Gb, it was the straw that broke the camel's back.

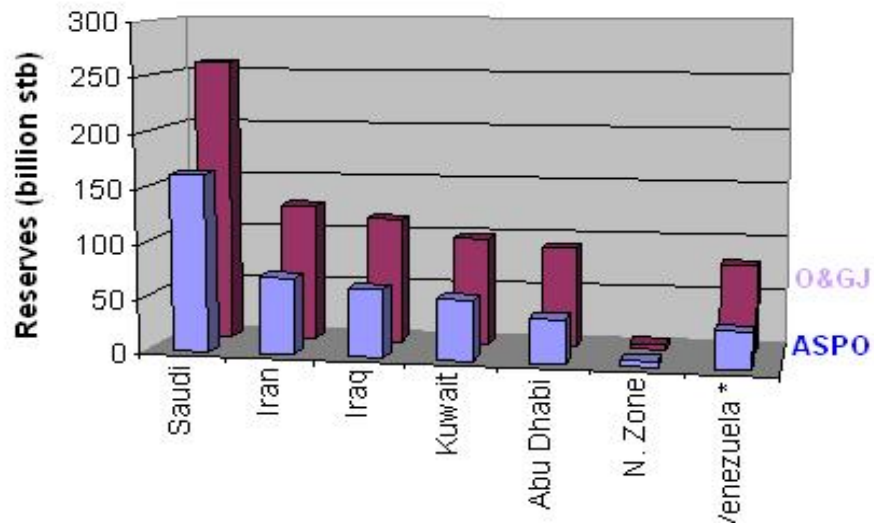
Abu Dhabi announced 92 Gb (exactly the same as Kuwait), up from 31 Gb; Iran went one better at 93, while Iraq, not to be outdone, came in with a rounded 100 Gb. Venezuela could not match but doubled its reserves from 25 to 56 Gb.

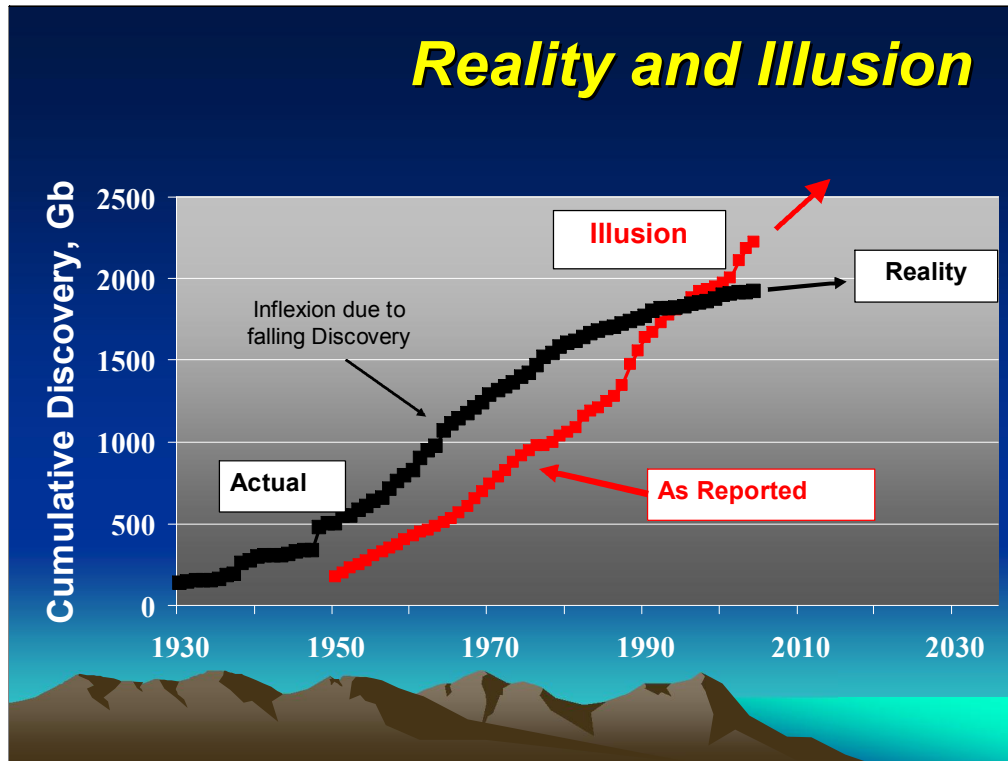
Saudi Arabia also could not match Kuwait because it was already reporting more, but in 1990 increased from 170 to 259 Gb following Kuwait's example of reporting the total found, not the amount remaining when it.

But, significantly, the Neutral Zone, which is shared by Saudi Arabia and Kuwait, announced no such increase – presumably because its two owners had no common motive.

This explains why the reports have barely changed since, despite massive production, as shown in green. It is remarkable that such a flawed dataset is routinely reproduced without comment.

Realistic OPEC Reserves?





This shows the trend of discovery. The public numbers in red have deceived most economists into believing in perpetual growth.

But if we plot sound estimates, with revisions properly backdated to discovery, as released by Exxon, we get a very different pattern of decline, shown in black.

The link between discovery and production a few examples

The same general pattern everywhere

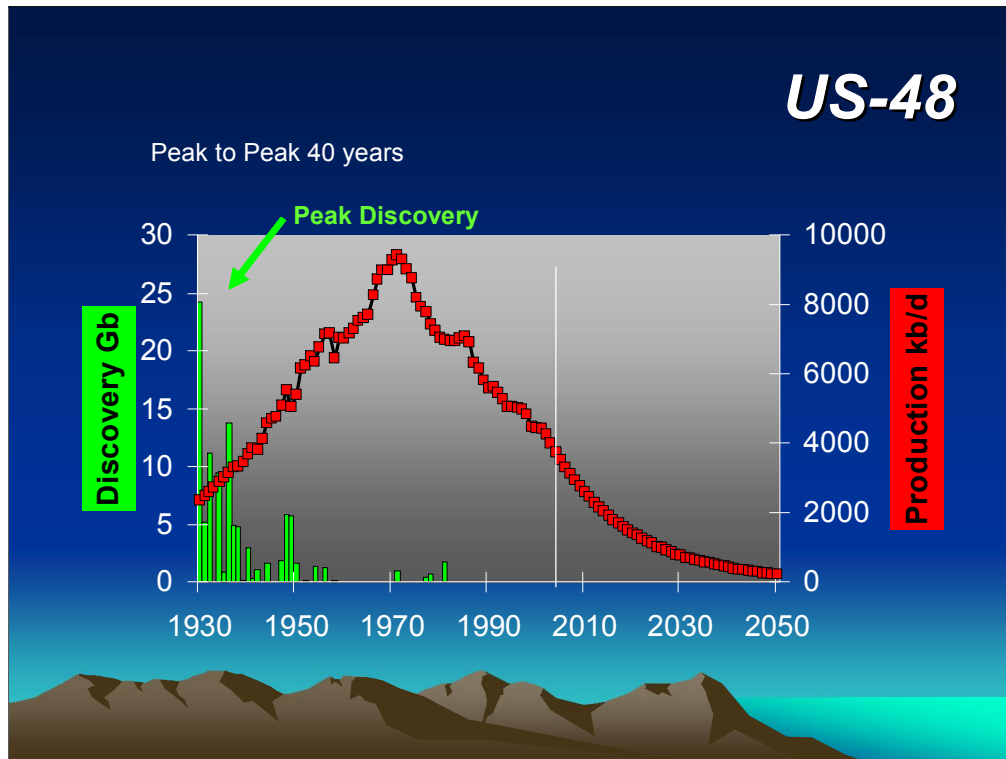
- Discovery episodic, the larger finds first
- Production smooth

Production naturally mirrors discovery



I will now move on to show the essential relationship between discovery and production with a few examples.

The same pattern is being repeated everywhere with only minor variations.



This shows the US-Lower 48, which is the world's most mature area.

Discovery peaked in 1930 giving the corresponding peak of production 40 years later - in 1970.

- This is a relatively long time-lapse, because technology was primitive in those early days.
- Also, the United States had a unique environment with the landowner owning the mineral rights, meaning there were many small operators.

Production has been in relentless decline for 35 years.

- Nothing can change it.

It explains why the United States is so desperate to secure access foreign oil, if necessary by military means.

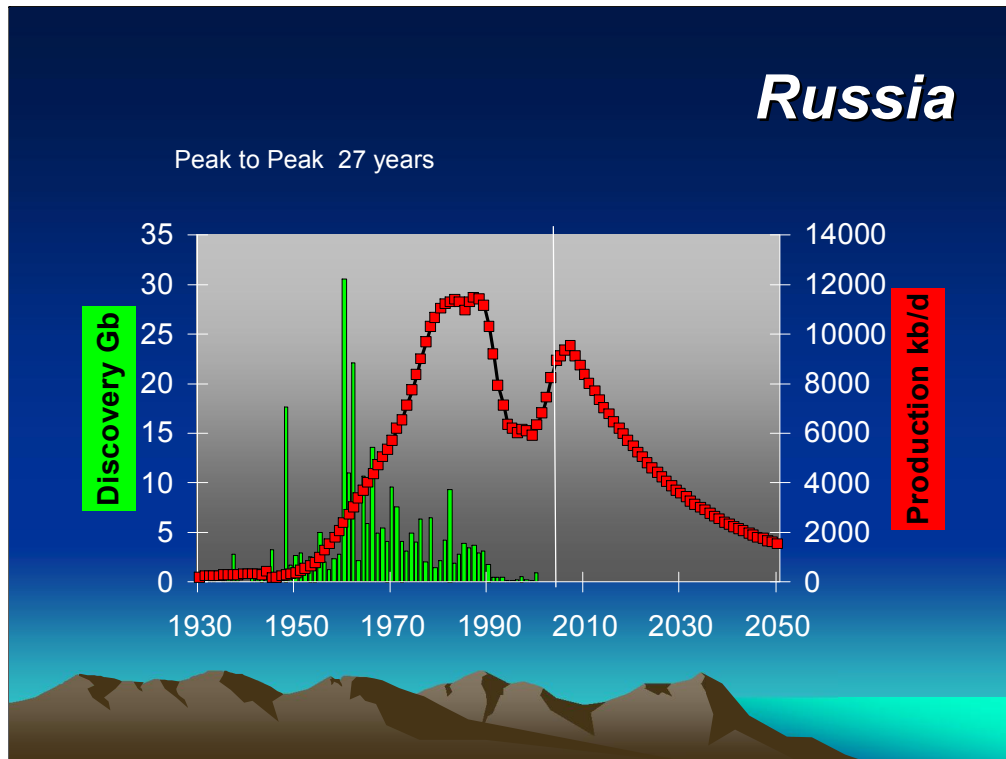


Indonesia has had a long oil history. It was the birthplace of Shell Oil in the 19th Century. An early cycle of onshore discovery peaked in the 1940s, and was followed by a second offshore peak in the early 1970s.

The discovery cycles were faithfully reflected in production.

Production is now in terminal decline at about 3.5% a year. The country has no good reason for remaining a member of OPEC, as it becomes an importer.

It is a populous country of some 218 million.



Some of the world's first oil wells were drilled in the 19th Century on the shores of the Caspian, which was then Russian territory.

Exploration was curtailed during and between the two world wars, but expanded rapidly during the 1950s when most of the productive basins and the giant fields within them were found.

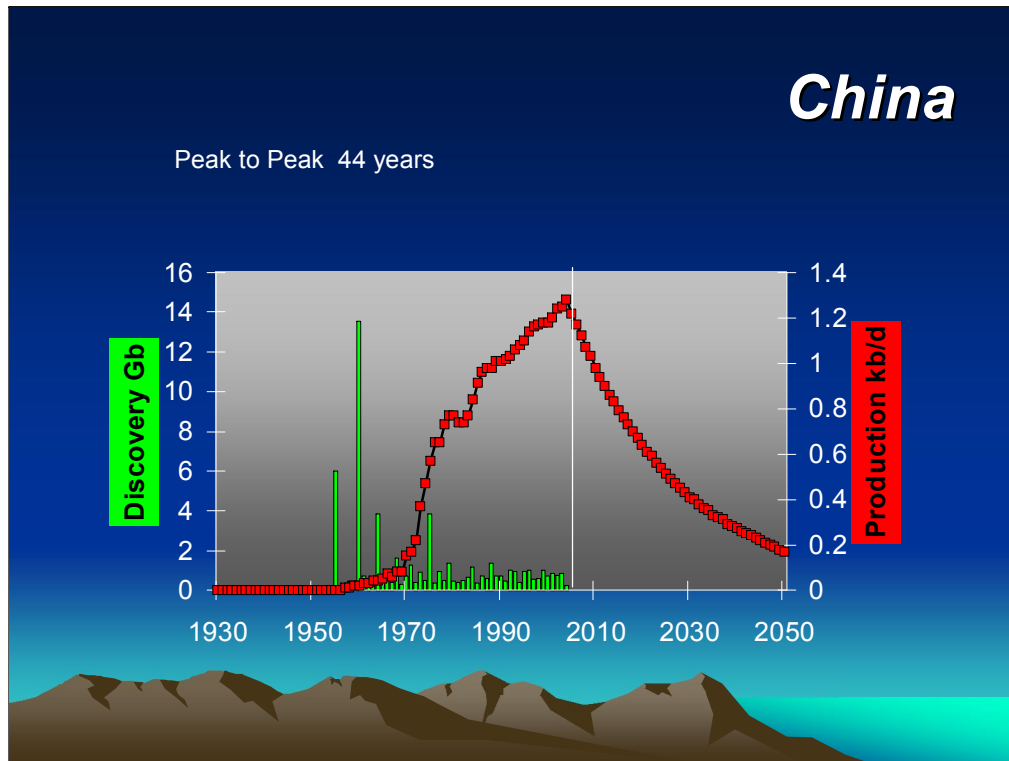
Being free of market pressures, the Soviet explorers were able to conduct high quality scientific exploration. They were the pioneers in the critical subject of geochemistry.

Discovery peaked around 1960.

Production rose to a peak in 1987, when some fields being over-produced under the last days of the Soviet regime. It then slumped before recovering as new private Russian companies stepped in. In part, they were making good what would have already been produced but for disruption caused by the fall of the Soviets.

But now, the Government is regaining control and will try to conserve its resources. Production is expected to grow only slowly, if at all, to a second peak in the next few years.

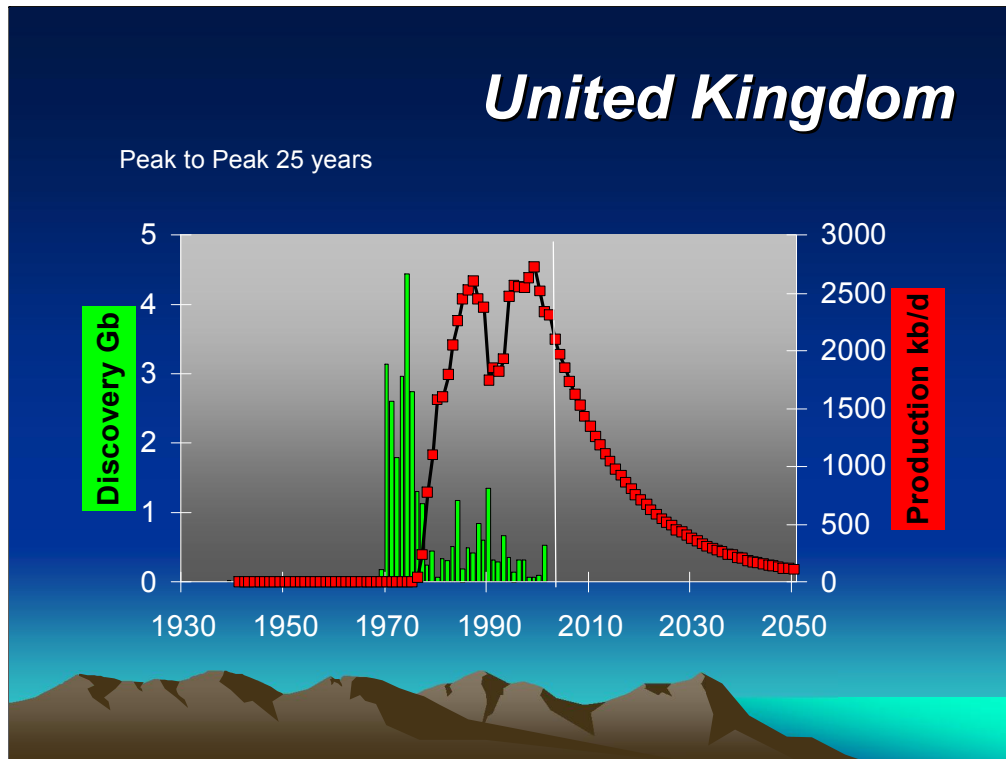
Russia's consumption is still relatively low at about 2.5 Mb/d. At this level, it can remain a net exporter for about 30 years, giving it great geopolitical strength.



China is not a rich oil country for geological reasons.

Production is now set to decline at about 4% a year.

But consumption is soaring from new economic prosperity, putting it on a collision course with the United States for access to the Middle East.



The United Kingdom shows the same classic pattern.

Discovery peaked in the 1970s as the giant North Sea fields came in.

That delivered a corresponding peak in production in 1999. It is now declining at about 6% a year.

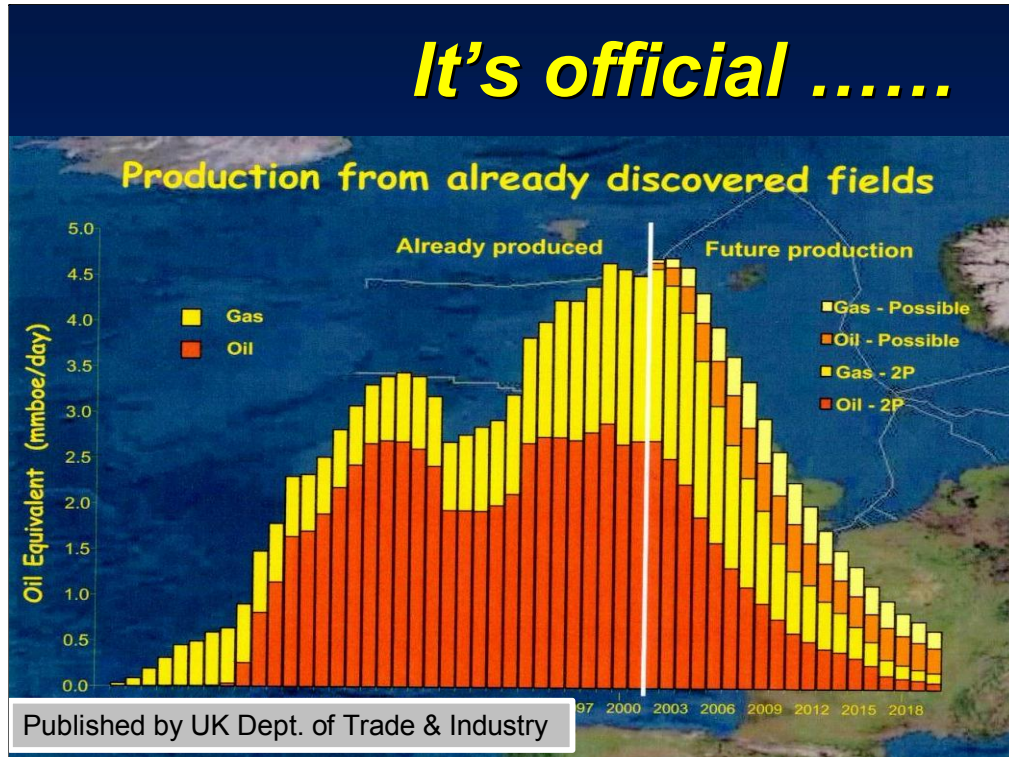
The brief fall in production in the 1990s was due mainly to the Piper Field accident which closed several platforms for maintenance and improved safety.

The country becomes a net importer next year on a steeply rising trend.

Mrs Thatcher created an open market environment bringing in all the famous attributes of enterprise, competition, initiative, imagination.

At first, the policy seemed a great success, lowering the price to the consumer, but as a result the country consumed its inheritance in a few years of profligacy.

It is a nice example of a country that failed to grasp the supreme irony of depleting a finite resource : *the better you do the job, the sooner it ends.*



This demonstrates Britain's position.

Surprisingly, this realistic forecast has been published by the Department of Trade and Industry.

- No doubt it slipped out unintentionally as now they say they lack the staff to update it.

It shows that Britain's oil and gas will be virtually gone in 15 years. The cost of imports is soaring.

This is the most critical issue facing the country yet failed attract the attention of any of the main parties in the recent election.

53 countries are past peak

Pre-1970 - Austria, Germany

1970s - Venezuela, Bahrain, Ukraine, Libya, USA, Turkmenistan, Canada, Iran, Romania, Indonesia, Trinidad, Brunei, Algeria

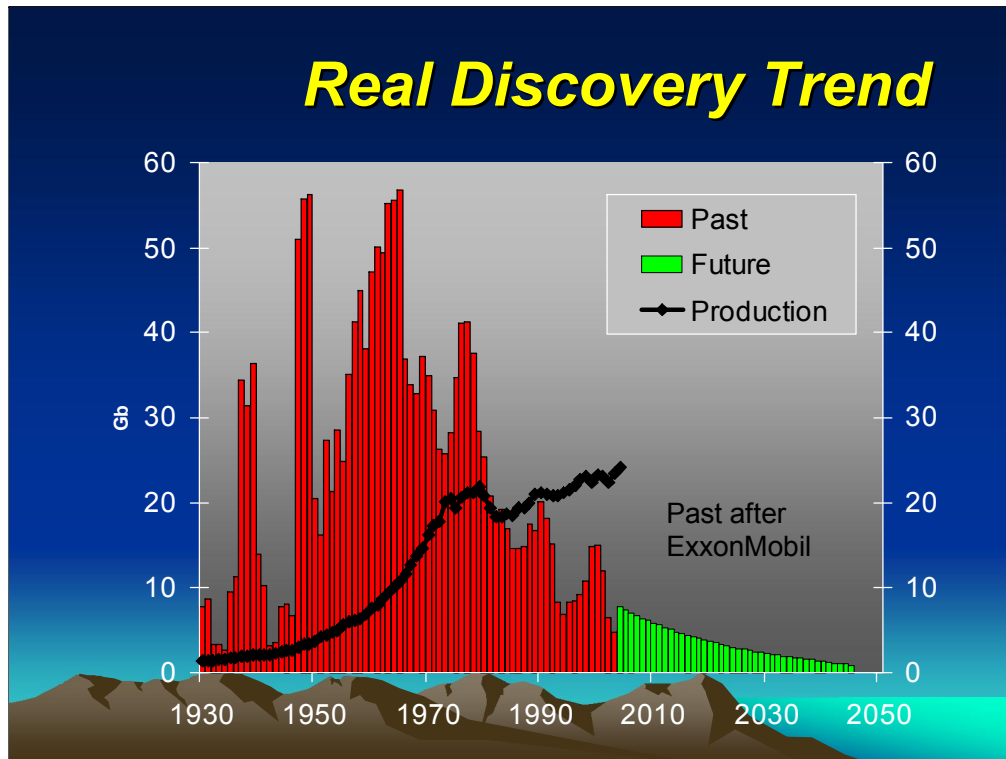
1980s – Tunisia, Chile, Albania, Peru, Cameroon, Brazil, Hungary, Russia, France, Croatia, Netherlands

1990s – Turkey, Dubai, Pakistan, Papua, Syria, Egypt, Gabon, Argentina, Angola, Sharjah, Uzbekistan, UK, Colombia, Yemen

2000s – Mexico, Nigeria, Norway, N. Zone, Oman, India, Qatar, Malaysia, Australia, Ecuador, Denmark, Congo, Italy



Some 53 countries, including major producers, have already passed their peak. It is no surprise that the world as a whole passes peak too.



This shows the world situation. It is the most important slide I can show you. Exxon deserves huge credit for publishing it with good data and revisions properly backdated to discovery.

World discovery has been falling relentlessly for 40 years.

There is no good reason to expect the trend to change direction, so we can extrapolate to show what is yet-to-find, shown in green.

Consumption, shown in black, exceeded discovery in 1981, and the gap is widening.

Take a good look : it says it all.

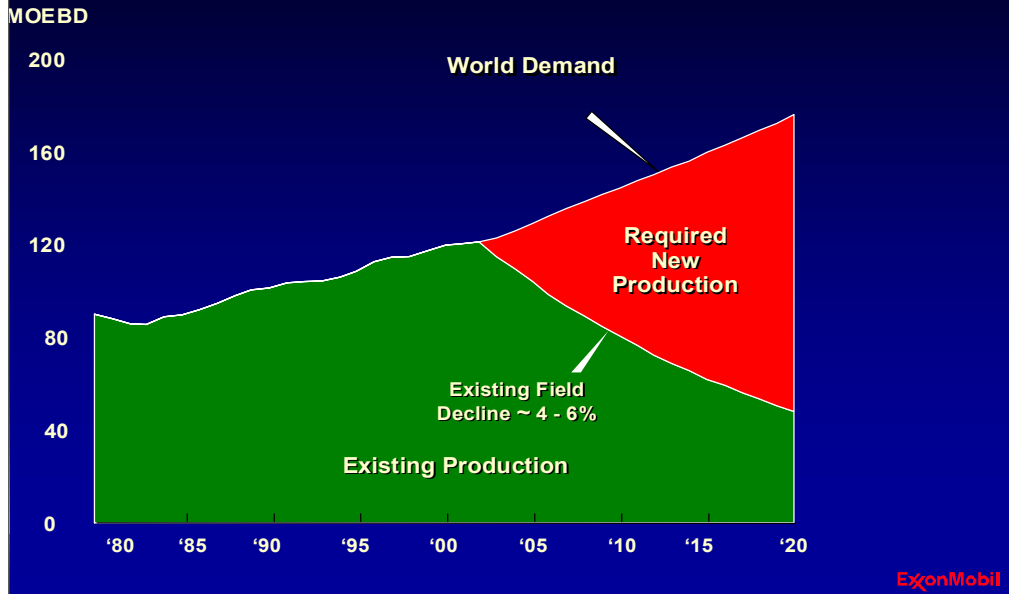
The problem we face

- **Unconstrained demand likely to reach 120 mbd by 2025**
- **Non-OPEC supply less than 65 mbd - probably much less**
- **Doubt over OPEC countries willingness and ability to increase offtake capability from today's 30 mbd to nearly 60 mbd**



Meeting the Challenge

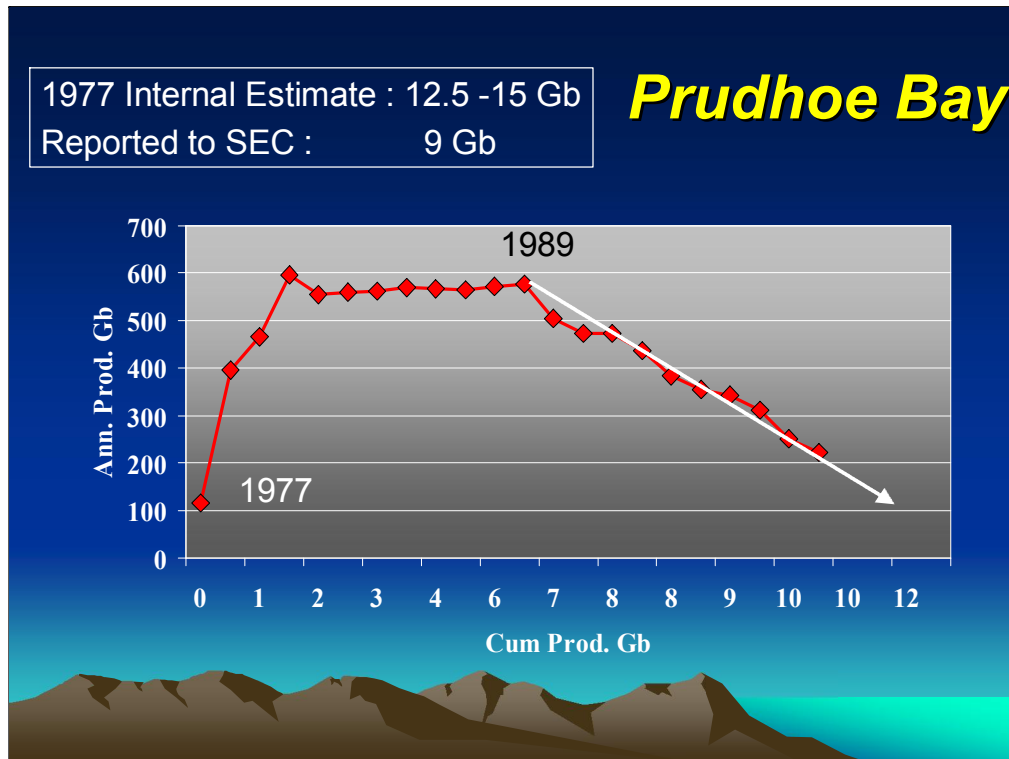
Industry Outlook - Oil & Gas Demand/Supply



Impact of New Technology

- Huge advances in exploration, drilling and completion techniques
- Production plateau maintained until later in field-life (improves economics but generally has little effect on reserves)
- Better estimates of EOR reserves benefits (but these have been generally disappointing)





This is well illustrated by the Prudhoe Bay field of Alaska.

In 1977, the operator internally estimated reserves of 12.5-15 billion barrels but reported 9 to meet strict Stock Exchange rules.

It was right to be conservative because it knew that the tail end would be costly, and it did not want to promise more to its shareholders than it was sure of delivering.

Despite the most advanced technology, decline commenced in 1989.

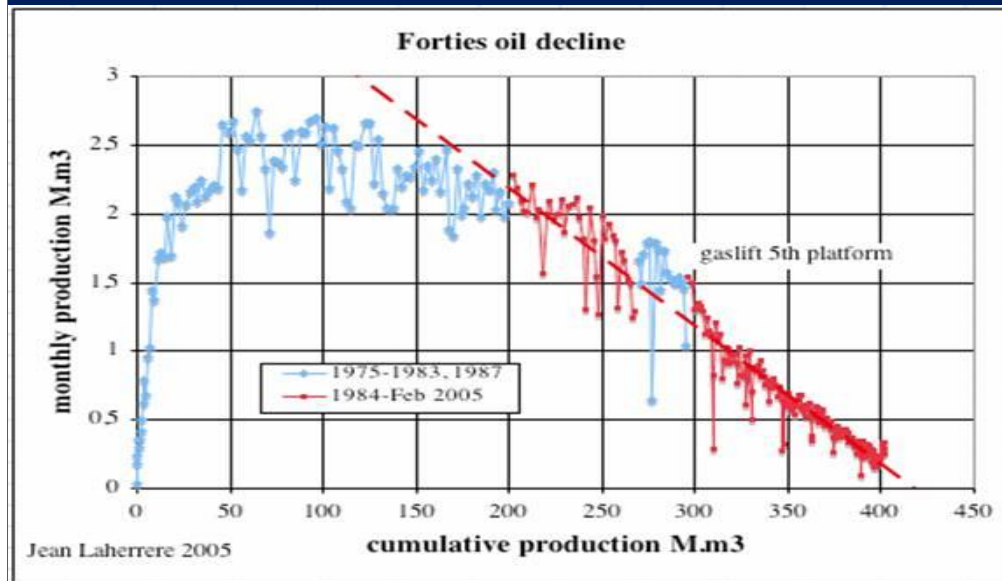
Extrapolating the downward trend shows it will barely make the original estimate.

Technology provided no more than it was expected to do.

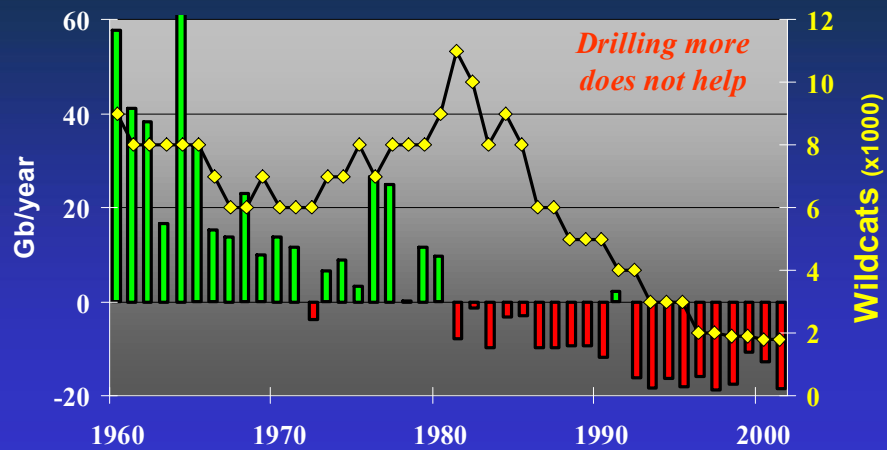
This example is quite typical. Most of the large North Sea fields were initially under-reported by about 30%.

But the luxury of under-reporting is almost gone as even optimistic assumptions have to be made for small deepwater finds, which may disappoint.

Forties Field Decline



The Growing Gap between Discovery and Consumption



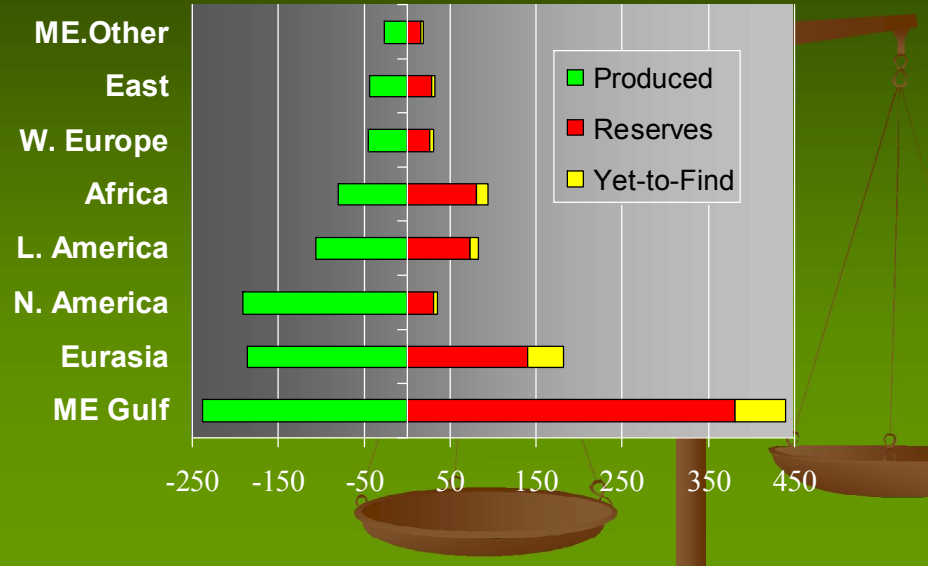
Reserves Summary

Original Reserves (billion stb)				
	Produced	Remaining		Total
	Known Fields		YTF	
Regular Oil	968	759	123	1850
All Oil	1074	1326		2400

"All Oil" includes Heavy, Deep Water, Polar, NGL



Where is it? Regular Oil



“Draining the tank”

Surprise

?

Filling at 5 p.a

122 Yet-to-Find

968 Produced
1728 DISCOVERED
760 Remaining

Emptying at 24 p.a.

One in - Five out

billion
barrels

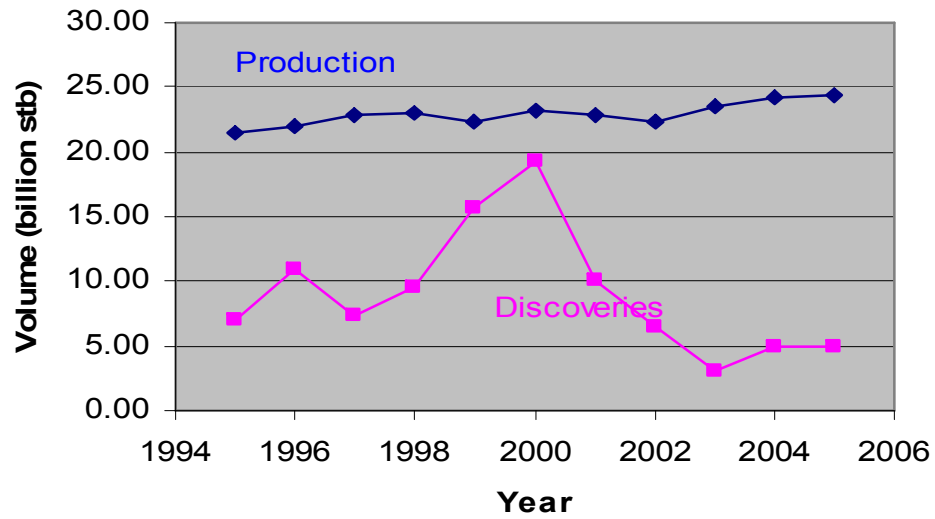


The Unfillable Gap?

- Demand increasing at ~3 mmbd/year
- Offtake decline (existing fields) ~ 4 mmbd/year
- So, new sources of 7 mmbd needed each year
- Recent typical discovery rate of <8 b bbls/year adds only about 1.5 mmbd each year



Emptying the tank!

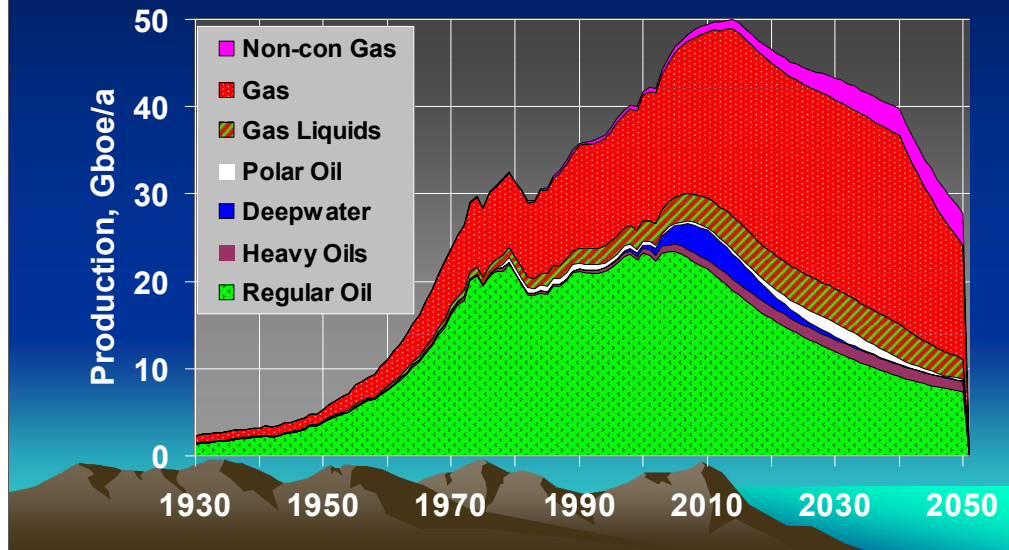


How much can/will OPEC help?

- Saudi: Technical limits; politically unstable?
- Abu Dhabi: Low depletion rate acceptable
- Kuwait: “Democracy” impedes IOC deals
- Iran: Internal consumption, political limits
- Iraq: No likely end to chaos



ASPO Production Prediction: All Oil & Gas



Putting it all together gives this picture.

- The Green is the Regular Conventional oil, now heading into decline.
- The Brown is the heavy oil of Canada and Venezuela, with production growing at a slow rate.
- The Blue is a brief surge from the deepwater.
- The White is some uncertain polar, perhaps from offshore Siberia.
- The Striped represents gas liquids.
- The Red is gas, which depletes very differently, being a gas not a liquid. Production tends to plateau, not peak, before coming to an abrupt end.
- The Purple is non-conventional gas, such as coalbed methane from coal.

The Peak of all liquids comes in 2007, with Oil & Gas combined coming only a few years later.

But don't be mesmerized by the date of peak. It can slide a little with different scenarios and estimates. Also, it is not a high peak but just the calculated maximum of a gentle curve.

What matters is the perception of long decline that follows.

the end